

2. PROJECT METHODOLOGY

This section introduces the project vision and approach, as well as describing the organization of this report. A guide to communications terminology is also included for general information and reference.

2.1 PROJECT VISION STATEMENT

To facilitate the development of the Communications Plan and to encompass the communication needs of the stakeholders; the project team proposed and accepted the following vision statement:

“Set Strategic Direction for the Implementation of a Statewide Communications Network to Serve the State Transportation Systems Management, Video, and Integrated Data Needs”

The steps required to meet this vision are discussed in the following subsection.

2.2 TASKS

Initially, this project was intended to provide communications requirements primarily for WSDOT’s ITS operations. However, once the project began, it became apparent that enterprise-wide guidelines were needed, and that there was an opportunity to provide greater benefit to WSDOT by considering a wider range of the organization’s requirements. The original project scope and task list was then revised and approved by the project team and stakeholders.

A work flow diagram is shown in Figure 1. The following tasks were undertaken in the preparation of the Communications Plan:

Review Work to Date: To gain a complete overview of WSDOT’s communication efforts to date, the project team reviewed all past work on the Light Lanes project and other relevant documents provided by WSDOT.

Stakeholder Input: Project stakeholders, in this case WSDOT regional traffic engineers, were interviewed in order to determine their perceived communications needs for current and future operations.

Determine WSDOT Enterprise Requirements: The project team conducted two working sessions with WSDOT staff, as well as over a dozen interviews with regional engineering, maintenance, telecommunications and IS/IT staff. The results of these meetings are discussed in Section 3 and were used to develop the requirements presented in Chapter 4.

Determine Center-to-Center Requirements: This task focused on statewide transportation data exchanges between WSDOT facilities in each region.

Determine Center-to-Field Requirements: This task focused on control and data exchanges between WSDOT Transportation Management Centers (TMCs) and associated field devices.

Inventory Existing Communications Equipment: WSDOT compiled an inventory of all existing and programmed communications infrastructure, including all fiber optic, microwave, twisted pair, hubs, etc. From this information, a geodatabase and GIS interface was developed to allow development of customized reports and maps.

Network Planning Study: The network planning study considered the communication needs of the WSDOT network and developed a plan to provide the required bandwidth between major communication hubs, including WSDOT offices and control centers. The network plan identifies communication links that are required by segment and by communication technology (microwave, leased line, owned fiber or other).

Assess Technologies: Using the results of the previous tasks, the project team was able to assess the ability and appropriateness of various technologies to meet WSDOT's requirements.

WSP Network Sharing Analysis: The purpose of this task was to work with Washington State Patrol (WSP) to gather information on the WSP statewide microwave backbone and radio network, as well as to identify and discuss institutional issues surrounding the opportunities for WSDOT to utilize this network. An important part of this task was to also gain a better understanding of WSP's requirements and to ensure that they are also supported by any final recommendations.

Telecom Market Survey: Telecommunications service providers, wholesale providers and others who may own and/or broker sales of telecommunications infrastructure in the State of Washington were surveyed, with the intent of looking for opportunities to buy (and/or long term lease) available fiber and/or bandwidth.

Evaluate Alternatives: Alternative communications concepts were developed and presented to stakeholders for evaluation, comment and review.

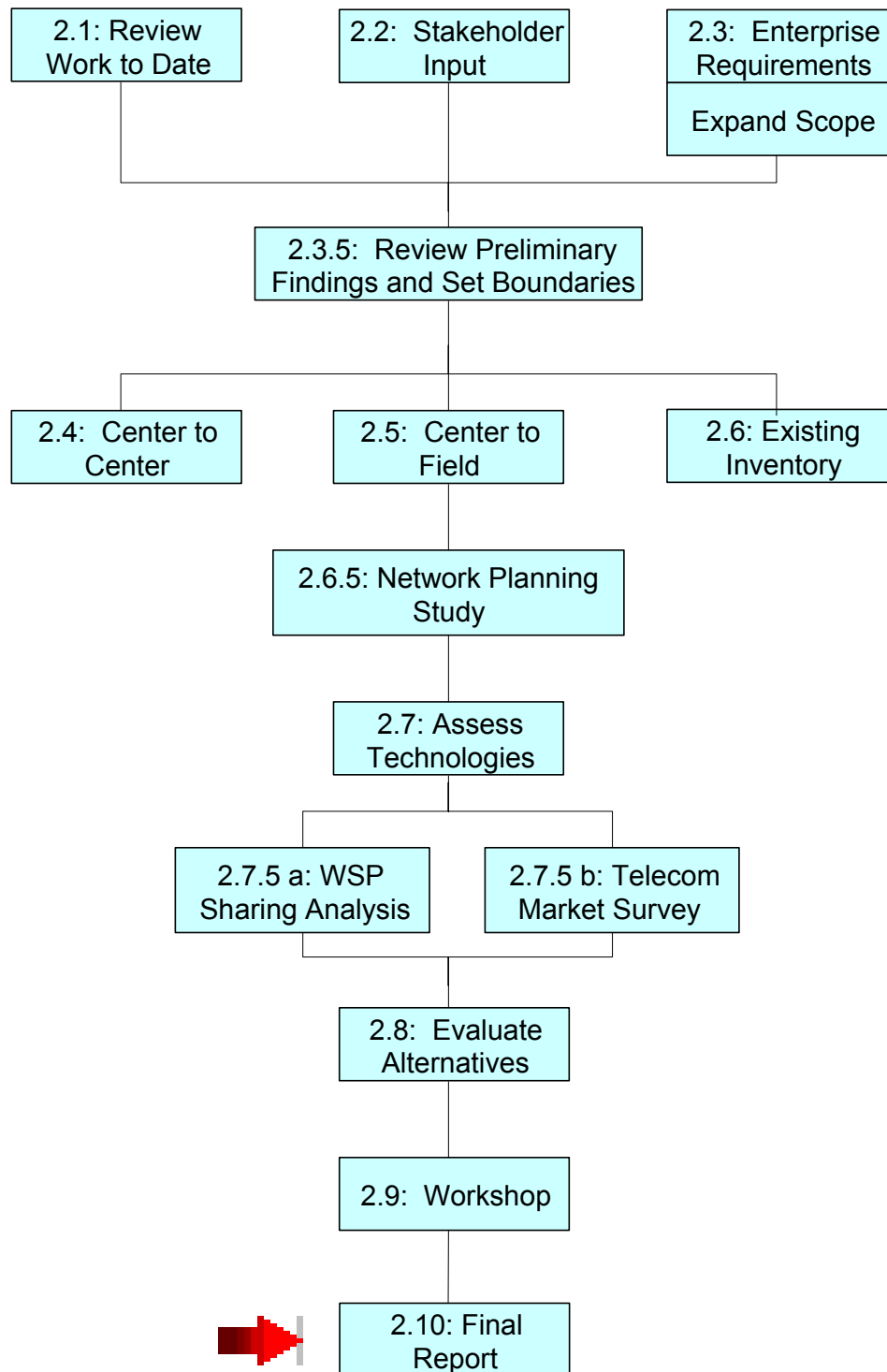


Figure 1: Communications Plan Workflow

2.3 FORMAT OF FINAL REPORT

2.3.1 Report Chapters

The Final Report is broken down into the following four Chapters:

- **Chapter 3: Findings**—this section introduces issues identified during interviews, report reviews, meetings, presentations and other data collection efforts.
- **Chapter 4: Requirements**—this section identifies a list of requirements of the WSDOT Communications network, identified as a combination of industry “best practices” and agency needs as identified in Findings.
- **Chapter 5: Analysis**—this section includes a compilation and review of data and information, with particular focus on agency requirements and existing infrastructure. This analysis involved development of specialized GIS maps to analyze specific issues and opportunities.
- **Chapter 6: Recommendations**—this section includes a high-level “Strategic Direction Statement” for the WSDOT Communications Plan and a series of specific recommendations.

2.3.2 Report Categories

Each of the four chapters are further broken down into the following categories (or subsections):

- **Inter-regional Communications:** Office-to-Office Data and Video communications requirements between WSDOT Regions or between a Region and State HQ—including IT, Enterprise and ITS
- **Intra-regional Communications:** Office-to-Office Data and Video communications requirements within a given WSDOT Region—including IT, Enterprise and ITS
- **Phone/PBX Network:** The WSDOT voice network, interconnecting the various offices on a network operated by WSDOT
- **Center-to-Field Voice Communications:** To vehicle and mobile handsets—including backbone and distribution communications
- **Center-to-Field Data and Video Communications:** To vehicle and/or field devices—including backbone and distribution communications
- **Policy Issues:** Policy issues that impact either communications needs or specific recommendations

Some of the chapters contain additional subsections, as required, but each includes these six categories at a minimum.

2.4 COMMUNICATIONS TERMINOLOGY

This subsection provides some background information on common communications technology terms.

2.4.1 Traditional Telephone Lines

Traditional telephone lines use a pair of copper wires (a twisted pair) to provide an analog communication channel. While analog circuits are still widely used in telephone systems, voice channels are typically converted to digital signals at some point in the network, and it is now rare that two telephone callers would talk over an interconnected pair of wires for the entire route between them.

The first approaches to digitizing voice signals converted the analog voice channel to a data stream of 56 or 64 kbps. This level of digitization is termed a DS-0, for digital signal level 0. In later years it has become possible to compress voice into smaller channels than 56kbps, but DS-0 is still used widely as a basic building block for uncompressed channels.

2.4.2 Data Circuits

The 56kbps channel has been retained as the basic building block for a wide variety of data services that are leased by telecommunication providers, as shown in the following table.

Service	Data Rate	Common Protocols	Capacity	Equivalent Voice Channels
DS-0	64kbps	Voice RS-232 V-35; DS-0	One uncompressed Voice signal	1
T-1	1.544Mbps	DS-1 V-35	24 DS-0 Channels	24
T-3	45 Mbps	DS-3	28 T-1 signals	672
SONET OC-3	155 Mbps	SONET	3 T-3 signals	2,016
SONET OC-12	622 Mbps	SONET	12 T-3 signals	8,064
SONET OC-48	2.49 Gbps	SONET	48 T-3 signals	32,256
Frame Relay	Varies	V-35 RS232	Shared Capacity	Varies
Ethernet	10Mbps 100Mbps 1000Mbps	10Base-X 100Base-X 1000Base-X	2.5 Mbps 25Mbps 250Mbps (approximate capacity on shared channel)	44 440 4,400
Video (Uncompressed)	45Mbps	Proprietary	One NTSC Video	2,016
Video (Compressed)	10Mbps	MPEG2	One NTSC Video (compressed)	44

These circuits or leased lines are provided over the telephone network to the customer's premises. At the end of the leased line, a DSU (Data Service Unit) converts the signals carried by the telecommunication network into a standard data protocol as shown in the table above. In a point-to-point circuit, two locations would be connected with the leased line, and DSUs at each end of the circuit would allow the two locations to communicate using the selected protocol and data rate.

2.4.3 Frame Relay

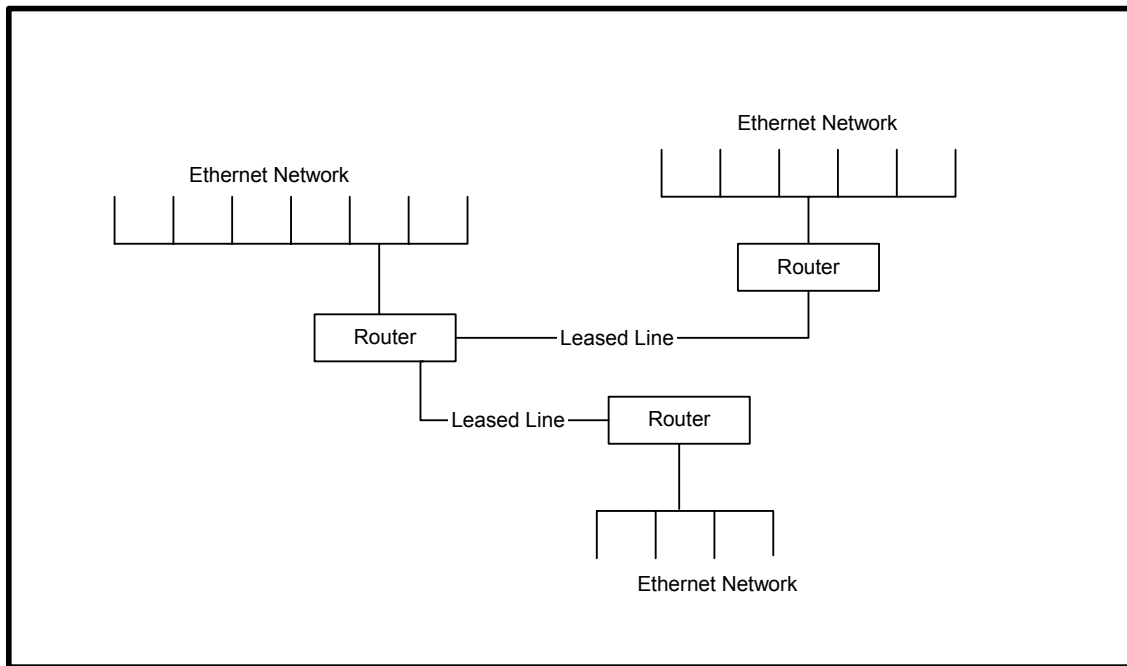
Before the advent of modern computer networks, it was common that one central computer would need to communicate with a number of remote locations. A point-to-multipoint circuit was developed to meet this need, which divided the stream of data up into small chunks (frames) and directed (relayed) each frame to the correct destination. These frame relay circuits are still available from telecommunication suppliers, and provide an economic means of combining the data traffic from a number of remote locations. For the purposes of this document, these groups have been termed "frame relay clusters".

2.4.4 TCIP/IP Networks

The vast majority of computer networks use Ethernet communication, which allows all connected computers to talk on a common channel. Similar to frame relay networks, the information to be sent is divided up into packets and sent out over a network to the intended recipient. The traffic is switched and routed to the recipient based on an addressing and routing protocol called TCP/IP (Transmission Control Protocol/Internet Protocol).

Ethernet requires large bandwidth connections operating at 10, 100 or 1000Mbps that can only be carried for short distances on twisted pair wiring. Although long distance transmission is possible using fiber optic cables, the telecommunication providers typically do not lease "dark" fiber without the electronics that light the fiber and provide the communication link.

In order to extend the span of an Ethernet network, routers are used at strategic locations. In addition to directing the transmission of the Ethernet traffic as the name suggests, routers can also translate Ethernet traffic into any of the communication protocols discussed above. With a leased line between two buildings, routers at each end can be equipped with appropriate WAN (Wide Area Network) interface cards as shown below.



2.4.5 WSDOT Networks

WSDOT has implemented a WAN that provides statewide interconnection of the TCP/IP network. The main state facilities are equipped with routers and interconnected with leased lines. At this time, WSDOT uses the following types of leased lines to interconnect the routers:

- 56kbps Point-to-Point
- Frame Relay (Typically with an aggregate bandwidth of 1.0 Mbps)
- T1 circuits
- T3 circuits

2.4.6 Network Monitoring and Utilization

All of the routers used by WSDOT are monitored and managed remotely over the network. This allows the IT group in Olympia to monitor the health of the network in real time, including the presence of the communication link and the utilization (traffic load) on each link. In addition to the real-time monitoring, the daily utilization of each leased line is well documented by the IT group, for historical trends and to identify links that require additional capacity.

Due to the nature of computer traffic, experience has shown that users will start to notice network delays when the utilization of WAN leased circuits starts to exceed 30%. When this utilization exceeds an average of 40% the problem will reach a significant level and the IT group will start to receive calls from dissatisfied users. The nature of WSDOT's network usage (like most entities) is that the traffic is continually increasing over time, so a level of 20% utilization has been adopted as an indicator that some action is required to provide additional capacity on a section.